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Histological study of the ray *Pseudohypolophus mcnultyi* (Thurmond) from the Late Cretaceous (Coniacian–Santonian) of central New Mexico

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Introduction

The genus *Pseudohypolophus* encompasses Cretaceous rays that lived in shallow water along the margins of the North American Cretaceous Interior seaway. This monospecific genus has a long stratigraphic range that extends from the Aptian to the Campanian, and teeth are common in shallow water marine deposits in New Mexico, Texas, Georgia, Nebraska, South Dakota, Wyoming, and North Carolina (Cappetta, 1987). The teeth of *Pseudohypolophus* are small, ranging from 1 to 5 mm in size. These locally very abundant teeth are collected by screen washing sediment and picking through concentrate. However, few workers make the effort necessary to

identify these teeth because they are minute and require histological examination of thin sections to identify them conclusively to the species level.

This is the case with previously published records of *Pseudohypolophus* from New Mexico. Thus, Wolberg (1985) reported "batoid indet." from the Tres Hermanos Formation in Socorro County, and these are probably teeth of *P. mcnultyi*. These teeth were not available to us for study, so a histological examination of them is not feasible. Teeth of "*Pseudohypolophus* sp." from the Dalton Sandstone and the Hosta Tongue of the Point Lookout Sandstone in Bernalillo County (Williamson et al., 1989) also pertain to *P. mcnultyi*, as we demonstrate here.

We examined the teeth of *Pseudohypolophus* reported by Williamson et al. (1989), which are from two localities, New Mexico Museum of Natural History and Science (NMMNH) localities 297 and 342. A third, nearby locality, NMMNH locality 4730, also provided teeth for this study (Johnson and Lucas, 2001). All three localities are in the middle Rio Puerco valley, in T11N R2W, on the Herrera quadrangle in Bernalillo County (Lucas et al., 1988). Two of the sites, 342 and 4730, are in the Coniacian Dalton Sandstone Member of the Crevasse Canyon Formation, and the third site, 297, is in the Santonian Hosta Tongue of the Point Lookout Sandstone (Lucas et al., 1988; Johnson and Lucas, 2001). Here, we report the results of our histological

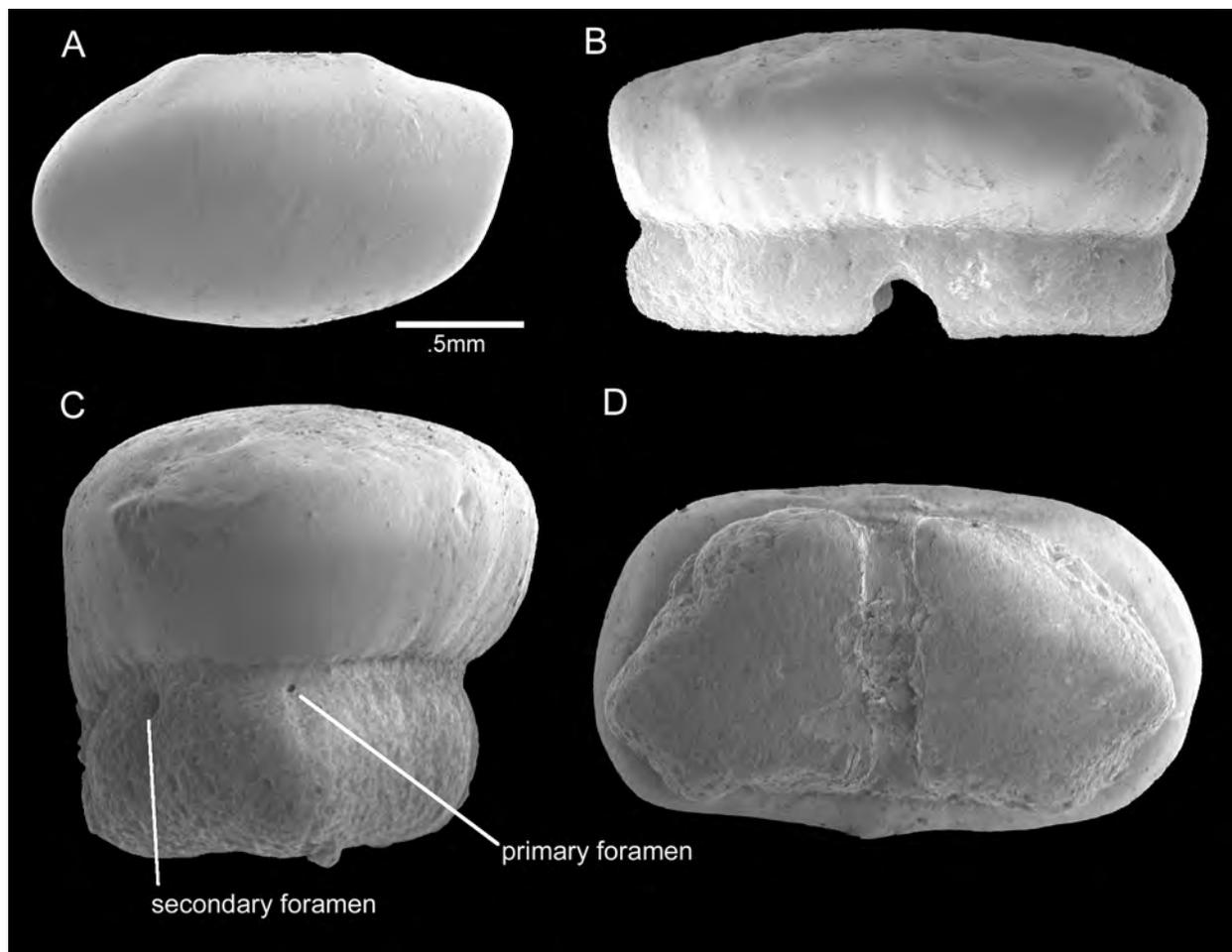


FIGURE 1—External views of teeth of *Pseudohypolophus mcnultyi*, catalogued as NMMNH P-35367, from locality 4730 in the Dalton Sandstone. Note that tooth in A is different from B–D, which are three views of a single tooth. A, Occlusal view. B, Labial/lingual view. C, Anterior/posterior view. D, Root view.

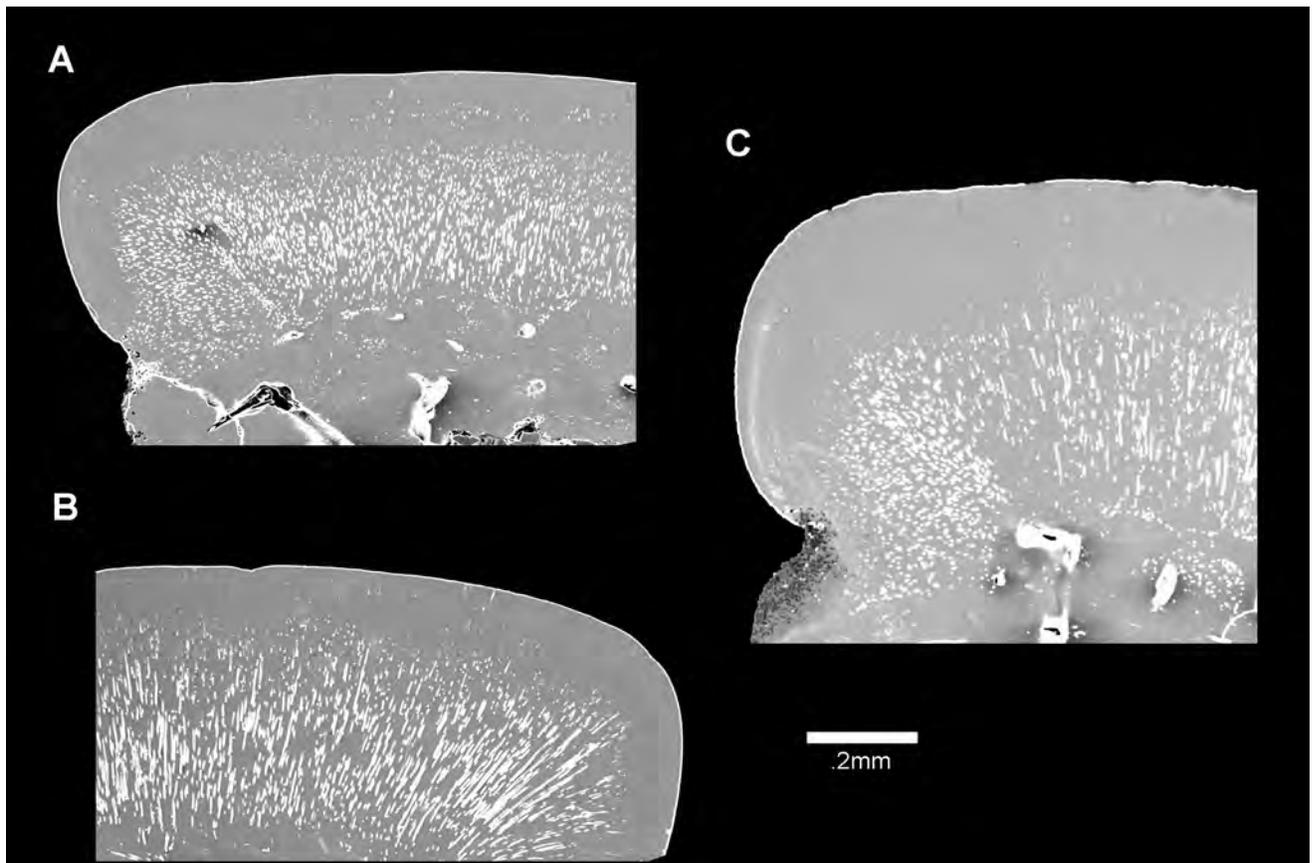


FIGURE 2—Cross-sectional views of teeth of *Pseudohypolophus mcNultyi*. **A**, Cross section of NMMNH P-35370 (from locality 297 in the Hosta Tongue of the Point Lookout Sandstone) shows clear distinction between the orthodentine and the osteodentine. **B**, Cross section of NMMNH P-35369 (from locality 342 in the Dalton Sandstone) shows radiating pores in the orthodentine. **C**, Cross section of NMMNH P-35368 (from locality 4730 in the Dalton Sandstone) shows the layers and the crystal structure of the enamel.

work and identify the *Pseudohypolophus* teeth from these localities to the species level.

Materials and methods

The three sites were surface picked, approximately 200 kg (440 lbs) of sediment from each of the sites was screen washed, and the concentrate was picked for the small teeth. The teeth of *Pseudohypolophus* were then further cleaned to remove sedimentary matrix from the roots. Four *Pseudohypolophus* teeth from each of the sites were embedded in epoxy. These teeth were then cross sectioned along the long axis of the tooth, polished, and carbon coated. We used a JEOL-JSM5800 scanning electron microscope (SEM) housed at The Institute of Meteoritics at the University of New Mexico Department of Earth and Planetary Sciences. The thin-sectioned specimens were studied at 20KeV, under standard vacuum, slow scan rates, and secondary electron imaging. Eight complete teeth were also examined to look at four different views of the external morphology (Fig. 1). The complete *Pseudohypolophus* teeth were uncoated and studied using low accelerating voltages; 2.5KeV worked the best for these teeth, with a fairly fast scan rate.

Systematic paleontology

Class CHONDRICHTHYES
 Subclass ELASMOBRANCHII
 Family Incertae Sedis
 Genus *PSEUDOHYPOLOPHUS*
 Cappetta and Case, 1975
PSEUDOHYPOLOPHUS MCNULTYI
 (Thurmond, 1971)

The external morphology of these teeth is oval to hexagonal in occlusal view (Fig. 1A). The long axis of the tooth runs labial-lingually in the mouth of the ray, and the teeth fit together to form a dental pavement. The side view of the tooth (Fig. 1B) shows the bifurcated root. In anterior or posterior view, the tooth's occlusal surface is slightly convex (Fig. 1C). The crown of the tooth overhangs the root, and the height of the root is approximately equal to the height of the crown. This view of the tooth also shows the blood vessel foramina (Fig. 1C). Each end of the tooth has two foramina. The primary foramen is very near the edge of the enamel crown of the tooth, and it is slightly off center from the primary axis of the tooth. The secondary foramen is slightly more distant from the enamel edge than the primary foramen. In basal view (Fig. 1D), the bifurcated root is clearly visible. Each half of the root is tri-

angular, with a nutrient groove that runs anteriorly-posteriorly down the center of the root. There are no foramina in the nutrient groove (cf. McNulty, 1964).

Teeth were thin sectioned lengthwise (Fig. 2). The root portion of the tooth contains the large blood vessels. The crown shows the distinct pattern of radiating dentine that defines the boundary between the clusters of orthodentine. The dentine radiates from the midline of the crown and extends toward the enameloid and in some cases enters the enameloid (Fig. 2B). The growth lines in the enamel are not very obvious when looking at the SEM pictures (Fig. 2C), but they are quite visible under a reflected light microscope. These teeth usually show three bands of growth lines in the enamel. Within these growth lines the crystals are perpendicular to the surface of the tooth, which is characteristic of sharks with a crushing dentition (Cappetta, 1987).

Discussion

The external morphology of these teeth is very similar to that described by McNulty (1964). McNulty compared the teeth that would later be called *Pseudohypolophus* to those of *Hypolophus sylvestris* and *Myleda-*

phus bipartitus. Externally, these teeth are identical, as are teeth of the modern ray species *Hypolophus sepan*. The internal histology of these teeth is what differentiates the taxa. Thus, in *Hypolophus* there is little to no orthodontine in the tooth, and that which is present forms a thin layer around the edge of the crown. In *Pseudohypolophus* the main body of the crown is composed of orthodontine.

Meyer (1974) noted that in *P. mcNultyi* teeth from the Aptian–Cenomanian of Texas there are distinct layers within the orthodontine in the crown, and in Turonian–Campanian teeth the orthodontine is homogenous. Our results are consistent in that the late Coniacian and Santonian teeth from New Mexico show a homogenous layer of orthodontine. This change in the layering of the orthodontine appears to be the only morphological difference during the entire stratigraphic range of these rays.

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